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ABSTRACT

This manual informs tutors/evaluators and students about the Caribbean Examinations Council's (CXC) school based assessment (SBA) of integrated science skills. It includes directions for the teacher/evaluator and a student activity package. The SBA is done in agricultural science, biology, chemistry, integrated science, and social studies and is designed to give teachers a greater role in the assessment of their students and to widen the range of abilities assessed. The evaluator's handbook describes the purpose and nature of SBA and outlines in detail the skills assessed: manipulation, observation, recording, interpretation, cooperation, and persistence. There is also a discussion of assessment timing (conducted four times in each of the last two years of secondary school), rating guidelines, procedures for conducting the assessment, recording the scores, the use of laboratory notebooks, and suggested activities. The Learner Activity Package includes an introduction to the SBA, a discussion of what scientists do, and a review of the six practical skills that the SBA looks for. The balance of the manual contains instructions for 32 assessment activities (for instance an activity to compare the effect of heat on temperature of water and soil). (JB)

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REGIONAL OFFICE
CASTRIES, ST. LUCIA , WEST INDIES

COMPREHENSIVE TEACHER TRAINING PROGRAMME

ED 392 767

INTEGRATED SCIENCE

SCHOOL BASED ASSESSMENT MARKER/TUTOR HANDBOOK

COMPREHENSIVE
TEACHER
TRAINING
PROGRAMME

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COMPREHENSIVE TEACHER TRAINING PROGRAMME

INTEGRATED SCIENCE

SCHOOL BASED ASSESSMENT

MARKER/TUTORS HANDBOOK

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INTRODUCTION

The School Based Assessment, (SBA) has several advantages over a one-shot practical examination.

1. Over a two-year period the marker/tutor is able to assess a student several times on practical skills. This means that an average performance can easily be determined. Assessment over time reflects a truer picture of the student's competence than a one-shot performance.

2. Because of time limitations a one-shot practical, does not usually capture a wide range of student behaviours. The SBA allows the marker/tutor to observe the student over a longer period of time and, this presents a truer picture of the student's work habits to be obtained.

3. By having the marker/tutor as the assessor, the SBA allows one with whom students will be comfortable to make the assessments so as to obtain purer measures of achievement.

To arrive at the score for performance in the practical skills, the marker/tutor should provide students with a variety of activities. To ensure that all students are being marked at the same standard, moderation and uniformity are two essential aspects of SBA.

PURPOSE OF SCHOOL-BASED ASSESSMENT (SBA)

School-based Assessment in Integrated Science (Single Award) serves the following main purposes:

(1) to assess those objectives of the syllabus which do not lend themselves to assessment by a written examination;

(2) to give candidates several opportunities to display their abilities under conditions that are familiar.

NATURE OF SBA

SBA is based on the following aspects of the syllabus:

(1) Skill in handling scientific apparatus and materials. (Aim 4)

(2) Objectivity and accuracy in observing. (Aim 5)

(3) Effective communication of observations using the language of science, e.g., through the choice of tables, graphs, diagrams, etc. (Aims 3 & 5)

(4) Ability to interpret and evaluate data obtained to make inferences or predictions and reach conclusions based on such data. (Aim 6)

(5) Willingness to work co-operatively. (Aim 9)

(6) Willingness to persist with a task to a logical conclusion. (Aim 10)

SKILLS FOR SBA

There are six practical skills for assessment. Each skill has two parts. The following is a list of the skills and some student behaviours that exemplify each skill.

1. Manipulation

Correct and careful handling of equipment and materials, e.g., good technique

- handles equipment and materials correctly to ensure safety,
- organises work space/apparatus to ensure safety.

2. Observation

(a) Using senses to perceive objects and events accurately:

- paying attention to details.
- positioning the sense organs (aided or unaided) to make accurate observations.
- making observations of an event several times to increase accuracy.

(b) Selection of observations relevant to the particular activity:

- selecting/using the measurement scales correctly.
- selecting aspects of observation relevant to the particular situation.

3. Recording

(a) Overall organisation and conciseness of report:

- writing reports in a logical sequence.
- naming each section of the report.
- selecting and using appropriate form(s) of reporting for conciseness.

(b) Accurate recording of observations:

- recording observations accurately, e.g., by graph, diagram, or prose.

4. Interpretation

(a) Extracting information:

- identifying trends and/or patterns from data.

(b) Making inferences, predictions and conclusions:

- making inferences.
- making predictions that are supported by data.
- extrapolating predictions or inferences to everyday life situations.
- making generalizations within limits of the data obtained.

5. Cooperation

(a) Degree of participation in executing a task:

- participating and assisting in any given activity.
- acting on group advice (that is considered reasonable).

(b) Sharing views, information and materials:

- sharing views, information and materials.
- offering advice to promote the good of the group.

6. Persistence

(a) Willingness to make every effort to satisfactorily complete the task or to take it to a logical point despite the difficulties of the situation.

(b) Willingness to recheck unexpected results:

- rechecking unexpected results, e.g., by redoing an experiment in part or in its entirety.

Marker/tutors will need to familiarise themselves with the definitions of these six skills. Once the definitions are understood, the way will be made clear for designing assessments that have a high degree of objectivity.

THE TIMING OF ASSESSMENTS

SBA should be conducted during Terms 2, 3, 4 and 5 of the final two years of the secondary school course. Marker/tutors must remind candidates of this syllabus stipulation at the beginning of each term.

The skills/qualities to be assessed during a particular term are indicated in Table 1.

Table 1: TERM ASSESSMENT OF SKILLS/QUALITIES (Sample)

CRITERIA	TERM 2	TERM 3	TERM 4	TERM 5
Manipulation	X		X	
Observation	X		X	
Recording	X		X	
Interpretation		X		X
Cooperation		X		X
Persistence		X		X

X indicates skill/quality to be assessed during particular term

RATING

Rating Scale

Each skill/quality should be rated on the following five-point scale:

4 - shows all characteristics very well

3 - shows all characteristics on an acceptable level or most very well

2 - shows only some characteristics to an acceptable level

1 - little evidence of most of the characteristics involved

0 - shows none of the characteristics

It is required of both teacher and candidate to keep neat and accurate records.

A. Practical Notebook

Each candidate is required to keep a practical notebook. The notebook should include at the front, a 'List of Contents' showing:

1. the practical activity undertaken
2. the date on which the activity was carried out
3. the page on which it was recorded.

CXC will require a sample of candidates' practical notebooks for external moderation, and will indicate the names of candidates whose books should be submitted. All other notebooks must be retained by the school for at least three months after publication of examination results.

B. Marker/Tutors

Teachers will be supplied with the following:

(1) A record book

(2) School-Based Assessment record cards.

Assigning SBA Marks

Each skill contains two criteria and carries a total of 4 marks. (The criteria are labelled (a) and (b) respectively, in the preceding section). A criterion for any one skill is worth 2 marks. The marks for a criterion can range from 2 to 0.

The mark awarded to a student should reflect the student's level of competency in the skill being assessed. The marks for each criterion could be awarded on the basis of one or more than one behaviour in the activity being performed. Examples of this are given in the Handbook provided.

It is not necessary, however, to assess performance in a skill using both criteria in any single activity. A marker/tutor may wish, for example, to focus on criterion (a) in manipulation in one activity and on criterion (b) in manipulation in another. The important consideration is that, by the end of the period of assessment, both criteria are assessed in each skill. The syllabus states, too, that each skill should be assessed at least twice during each of years 4 and 5.

PROCEDURES FOR CONDUCTING SBA

The assessment of practical skills involves the following six steps.

Step 1: Task - selection of the task/investigation and the corresponding syllabus objective

Step 2: Marker/tutor - breakdown of marker/tutor's preparatory work

Step 3: Analysis of Task - breakdown of work to be done by student

Step 4: Skills to be Assessed - listing of skills that could be assessed

Step 5: Task Components for Assessment

Step 6: Recording of Marks

Details of the six steps are outlined below:

Step 1: Task

The task selected should provide opportunity to measure a variety of skills and should match a given syllabus objective.

Step 2: Marker/tutor's Preparation

After selecting the task, the marker/tutor should prepare the required apparatus and materials. The marker/tutor should also perform the activity ahead of the students. This can help in determining the steps involved and the skills that can be assessed.

Step 3: Analysis of Task

The marker/tutor will need to list in sequence all the things the students will have to do in a given task.

Step 4: Skills to be Assessed

Before selecting the skills to be assessed the marker/tutor should list all the skills that could be assessed. The following table could be used.

Example

SKILLS THAT COULD BE ASSESSED	SKILLS SELECTED
Manipulation	
Observation	
Recording	
Interpretation	

Because assessment of some skills might involve looking at several behaviours, marker/tutors are advised to select not more that two skills to be assessed in any activity.

Step 5: Task Components for Assessment

After selecting the skills to be assessed, the marker/ tutor should list the task component (i.e., the area of activity) in which those skills would be assessed. The marker/tutor should also identify the criteria to be used in assessing each component. (Some marker/tutors may wish to break down the components further into student behaviours for assessment).

Step 6: Recording of Marks

A proper record of marks is essential. Marks for each student can be recorded on a mark sheet as described in the section below:

RECORDING SBA MARKS

The syllabus requires that teachers submit to CXC a Record Card showing the candidate's average mark for the year in each skill. In order to arrive at the averages, marker/ tutors should assess the students at least twice per year in each skill and record the marks in a Record Book. The marker /tutor retains the completed Record Book.

Since there are two assessment criteria (a) and (b) associated with each skill, a slight modification of the Record Book as shown below might prove useful. By dividing each 'Mark' column into (a) and (b), the marker/tutor can record marks scored on each of the two criteria when assessing. Thus, at a glance, the marker/tutor will be able to tell if each student was assessed under all of the criteria described in the syllabus.

SKILLS	MANIPULATION				OBSERVATION				RECORDING			
	Mark	Mark	Mark	Avg. /4	Mark	Mark	Mark	Avg. /4	Mark	Mark	Mark	Avg. /4
	(a)(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)

Fig. 1 Modified Record Book

Using a Checklist

Assessing students in some of the skills, e.g., recording and interpretation, could conveniently be done by marking the students' Laboratory Notebooks. A marker/tutor can read and re-read a piece of work written up and assign marks quite easily for each student. However, in skills such as manipulation, cooperation and persistence, a marker/tutor must write down marks as things are happening (unless, of course, you have a very good memory). A convenient way of doing this is by using checklists.

Examples of checklists drawn up for the relevant skills can be found in Section J of the Handbook. The column headings reflect the key aspects described in the marking schemes, i.e., what the marker/tutor is looking for. A tick (/) may be used to show that the student was displaying a satisfactory behaviour at the time the marker/tutor checked. A student may receive more than one tick in one of the boxes if the market/tutor checked that student more that once

during the performance of the activity. A zero (0) may be used to show that the student was displaying an unsatisfactory behaviour at the time the marker/tutor checked. Thus a tick and a zero will indicate that the student is erratic.

The ticks and zeros in each box should help the marker/tutor decide on a mark for the student.

LABORATORY NOTEBOOKS

Laboratory Notebooks are required by CXC in order to help moderate marker/tutors' scores.

The following information concerns the use and organization of these note books.

1. The notebook should contain all the practical work which the student does.

2. A list of contents giving the practical activity, the date it was done and the page should come at the beginning of the notebook.

3. Those activities used for SBA should be easy to identify.

4. Marker/tutors should indicate the marks awarded on each activity selected for SBA and show how the marks were awarded.

   The total possible marks should also be stated.

   e.g., MANIPULATION (a) 2
   --
   2

   RECORDING (a) (b) 3
   --
   4

   The rules must be recorded in the student's notebook.

5. The notebook should contain a wide variety of practical activities that:

   (a) allow for the assessment of the six skills at least twice a year

   (b) are spread over the four sections of the syllabus.

Together with the notebooks, Information Sheets on the activities selected for SBA are necessary. These Information Sheets should be submitted and keyed to the appropriate activity in the notebook (by using the same numbering).

SOME SUGGESTED ACTIVITIES

The Module writers, in an effort to help the marker/tutors, and to provide some consistency of activities, have given some suggestions of the activities/experiments for SBA. The intention has been to choose at least one activity from each Module, where appropriate.

In the event that no activity lends itself to such assessment, the writers suggest other related ones.

Each marker/tutor should endeavour to take each student through these activities, and to assess them using the CXC prescribed procedures.

Bear in mind the various deadlines for submission of these marks to CXC.

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SCHOOL BASED ASSESSMENT
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LEARNER'S ACTIVITY PACKAGE

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INTEGRATED SCIENCE

INTRODUCTION

School Based Assessment (SBA) is one of the major new ideas put forward by the Caribbean Examinations Council (CXC). SBA is done in Agricultural Science, Biology, Chemistry, Integrated Science and Social Studies. It has "the potential for giving teachers a greater role in the assessment of their students, widening the range of abilities assessed, permitting more valid assessment of some abilities for which pencil and paper tests and examination conditions are not the most appropriate, and generally increasing the adequacy of the evidence on which judgements of performance are based, both in terms of frequency of assessment and range of abilities assessed".[1]

The intention of the SBA then is to give you practice in designing and conducting experiments, making observations and conclusions, communicating and reporting in such a way that everyone can understand what you are saying. Communication, of course, may be in words or drawings or diagrams or graphs, etc. In your syllabus this intention of SBA is listed in the form of two broad objectives:

1. to assess those objectives of the syllabus which do not lend themselves to a written examination;

2. to give the candidate several opportunities to display his or her abilities under conditions that are familiar.

You will no doubt find the activities of SBA difficult at first, especially if you have not done a lot of this stuff before. However, as you get the hang of them, and with help from your Marker/Tutor or a friend, you will begin to enjoy them.

Here is some information that should help you to feel less timid about SBA activities. The information comes from students like yourself who have been asked how they feel about SBA. Many students feel that, from the standpoint that SBA assesses practical work and attitudes, they are very happy.

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1 King & Brathwaite, 'The Impact of CXC School-based Assessment in Science: Teacher and Student Perceptions, in Proceedings of 1990 Cross Campus Conference on Education, Faculty of Education, Mona, 1991, p.161.

2 Integrated Science (Single Award) Syllabus, General Proficiency. June 1986, CXC, p.4.

The following feeling was expressed by a student from St. Kitts/Nevis: "The SBA give a student a good chance to get a high mark for CXC exam."[3]

Another student from the Commonwealth of Dominica puts it this way: "The advantages are exceeded by the disadvantages. I can surely say that SBA is one of the best things to have been introduced .... It must be continued!"[4]

WHAT SCIENTISTS DO!

Many modern writers on science teaching and learning believe that one of the best ways to learn science is by doing what scientists do. Some people call it learning to be a scientist.

The participants at a recent workshop in Science Education explain how learning in science takes place in this way:

> "Science is a human enterprise through which we come to some understanding of biological and physical aspects of the world around. This'understanding' involves the development of ideas and concepts which enable related situations, objects or events to be linked together so that past experience enables us to cope with new experience .... Learning in science proceeds in much the same way. There is plenty of evidence from teachers' experiences as well as from research which shows that [children] strive to make sense of new experience in the classroom and elsewhere in terms of their already existing ideas"[5]

One of the major activities of scientists is investigating. Indeed this is one of the major activities of all living things. The participants mentioned above, who study how science should be taught and learnt, have suggested that there are ten 'things that scientists do'. They believe that learners should be involved in these 'processes of science', and by so doing they will develop some understanding of the biological and physical aspects of the world around.

Does all this sound exciting? Well it is. You are now entering an interesting aspect of science.

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3 King & Brathwaite, op cit, p.164
4 King & Brathwaite, op cit, p. 165
5 Harlen, W. (Ed.) Primary Science Teacher Training for Process-Based Learning. Commonwealth Secretariat/UNESCO, 1987.

There is one important thing you should bear in mind. When the emphasis is on the processes of science or what scientists do, there is no right or wrong answer. Maybe when you did science before, the teacher stressed that your 'answer' was 'right' or 'wrong'. This gave the impression that the product or outcome was most important. This module is suggesting that what you do to get the answer is perhaps more important.

Look at the diagram below which shows the process of science, as put forward by the participants I told you about earlier. The figure is followed by some statements, one for each process, that attempt to explain what the process is all about.

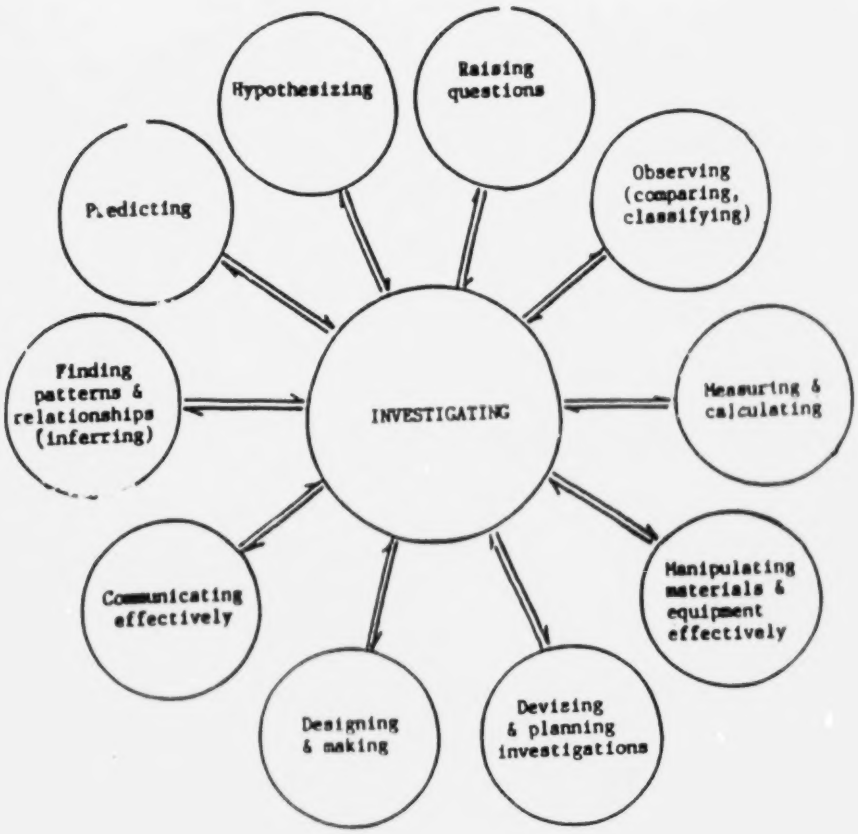

Fig. 01: Processes of Science

6 Harlen, W. (Ed.) op cit, p.17

Let us look more closely at these processes.

Observing: Taking in information about all things around, using all of the senses as appropriate and safe; identifying similarities and differences; noticing details and sequence; ordering observations.

Raising questions: Asking a variety of questions, through words or actions; gradually recognising questions which can be answered through scientific investigation.

Hypothesising: Suggesting reasons for events or phenomena which can be tested scientifically; involves applying concepts and ideas from previous experience.

Predicting: Going beyond the immediate evidence or past evidence, and using this to suggest what will happen at some future time; distinguished from a guess by the appeal to the evidence of present or past observations.

Finding patterns and relationships: Putting several pieces of information together and making some sense of the whole, through inference and identifying trends or correspondences or relationships; drawing conclusions.

Communicating effectively: Being able to present information so that it can be understood by others; being able to understand information from others in various forms; using graphs, charts, tables, diagrams, appropriately.

Designing and making: Using materials and scientific concepts to create articles and procedures for solving practical problems.

Devising and planning investigations: Proposing how to find out something through practical manipulation of materials; recognising the variables to be controlled and those to be changed and how this is to be done; deciding how to collect and record relevant data.

Manipulating materials and equipment effectively: Being able to put into practice the manipulation of objects with the precision required to obtain useful results; using equipment conventionally but imaginatively.

Measuring and calculating: Using measuring instruments correctly and with appropriate precision as required by the investigation; being able to compute results from measurements taken.

SKILLS FOR SBA

There are six practical skills for assessment. Each skill has two parts. The following is a list of the skills and some student behaviours that exemplify each skill. Note that they spring directly from the list of what scientists do.

1. **Manipulation**

   (a) Correct and careful handling of equipment and materials, i.e., good experimental technique.

   - handling equipment and materials correctly for accuracy
   - organising work space to ensure good results.

   (b) Due attention to safety

   - handling equipment and materials correctly to ensure safety
   - organising work space/apparatus to ensure safety.

2. **Observation**

   (a) Use of the senses to perceive objects and events accurately

   - paying attention to details
   - positioning the sense organs (aided or unaided) to make accurate observations
   - making observations of an event several times to increase accuracy

   (b) Selection of observations relevant to the particular activity

   - selecting/using the measurement scales correctly
   - selecting aspects of observation relevant to the particular situation.

3. Recording

(a) Overall organization and conciseness of report

- writing reports in a logical sequence
- naming each section of the report
- selecting and using appropriate form(s) of reporting for conciseness

(b) Accurate recording of observations

- recording observations accurately, e.g., by graph, diagram, table or prose.

4. Interpretation

(a) Extracting information

- identifying trends and/or patterns from data

(b) Making inference, predictions and conclusions

- makeing inferences
- makes predictions that are supported by data
- extrapolating predictions or inferences to everyday life situations
- making generalizations within the limits of the data obtained

5. Cooperation

(a) Degree of participation in executing a task

- participating and assisting in any given activity
- acting on group advice that is considered reasonable

(b) Sharing views, information and materials

- sharing views, information and materials
- offering advice to promote the good of the group

6. Persistence

(a) Willingness to make every effort to satisfactorily complete the task or to take it to a logical point despite the difficulties of the situation.

(b) Willingness to re-check unexpected results, e.g., by redoing an experiment in part or in its entirety.

LIST OF LEARNER SCHOOL BASED ASSESSMENT ACTIVITIES

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1. To Compare the Effect of Heat on the Temperature of Water and Oil

Materials:

small saucepan
bottle of cooking oil
watch (which can measure seconds)
water
thermometer
balance (scale)

Method:

1. Weigh a small dry saucepan. Note the mass.
2. Add 500 g water.
3. Light a burner on the stove and adjust the knob till a low flame is obtained. If not, mark the setting with a small piece of masking tape.
4. Place the thermometer in the water and note the temperature and the time.
5. Place the pan of water on the burner.
6. Record your observations in the table like the table below.

Time	Temperature of Water
0 min. (starting time)	
minutes	
minutes	

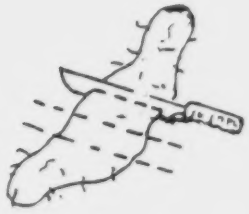
Table 01:

7. Repeat steps 1 - 6, using cooking oil instead of water. (Make sure that the temperature of the stove, the saucepan, the thermomete are the same).
8. Add another column to the Table and record your results. Make up an appropriate title for the table.

2. Osmosis

Materials:

- a yam
- tsp. sugar
- a knife



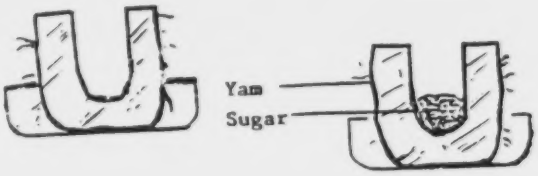


Fig. 01

Method

1. Cut two 3 in. lengths of yam. Stand each in a small container.
2. With a sharp knife dig a hole in the middle of the yam. Be careful not to cut right through the piece of yam. See fig. 01.
3. Place a half teaspoon of sugar and a few drops of water in the hollow of one block of yam. Leave the other hollow empty.
4. Leave the yam for about ° hour.
5. What do you observe? Draw your results.
6. Can you explain your observations?

You may use green paw-paw or irish potatoes instead of a yam.

3. To Find the Upthrust Using Different Fluids

Materials:

a 50 g mass

four 250 cm^3 beakers

spring balance

about 150 cm^3 of fresh water

about 150 cm^3 of sea water or saturated salt solution

about 150 cm^3 of methylated spirit

about 150 cm^3 of oil

an overflow can of capacity 150 cm^3

a beaker of capacity 100 cm^3

a piece of string

Method

1. Attach the 50 g mass to the spring balance with a piece of string.
2. Place the small beaker (100 cm3) at the end of the spout of the overflow can.
3. Pour fresh water into the overflow can until the excess water flows out through the spout.
4. Empty the small beaker and place it at the end of the spout.
5. Find the weight of the 50 g mass when it is suspended in air.
6. Record the reading in the table which followS instruction 11
7. Now place the 50 g mass in the water making sure that it is fully covered by the water. See figure which follows on page 13. Take the reading on the spring balance. This gives the weight of the mass when fully submerged in water.
8. Record your reading in the table which follows instruction 11.

9. Remove the mass from the fluid and empty the small beaker.

10. Repeat Steps 2 to 9 for each of the other fluids.

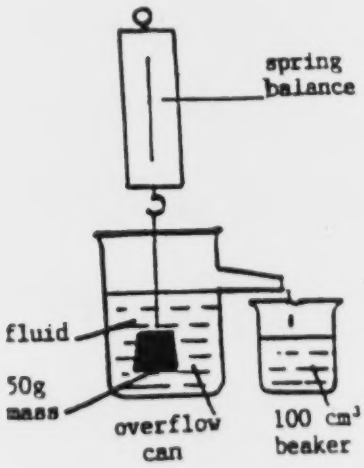


Fig. 02

11. Calculate the upthrust for each fluid and write the answer in the space provided in table 02 which follows.

FLUID	WEIGHT OF MASS IN FLUID	UPTHRUST
fresh water		
oil		
sea/salt water		
methylated spirit		

Table 02: Weight of Mass in Air

Which fluid provides the greatest upthrust?

4. Investigating Blood

Method

1. Obtain a prepared slide of a blood smear.
2. Examine it under the low power and high power of a microscope.
3. Try to identify the various blood cells.
4. If you can, borrow a freshly prepared blood smear slide [do not attempt to do this yourself] from a secondary school, examine it and compare it to the prepared slide. Draw the cells you see.

Skills to be tested

- manipulation
- observation
- recording

5. Do Non-living Things Respire?

Materials:

2 test tubes

2 cloth bags

some dead seeds

some germinating seeds

small amount of limewater

Method:

Using two test tubes, two cloth bags, some dead and germinating seeds and some limewater, set up an experiment as in figure 03 to show that living things do respire. (Wash the seeds in a little disinfectant). NB. Limewater turns milky in the presence of carbon dioxide.

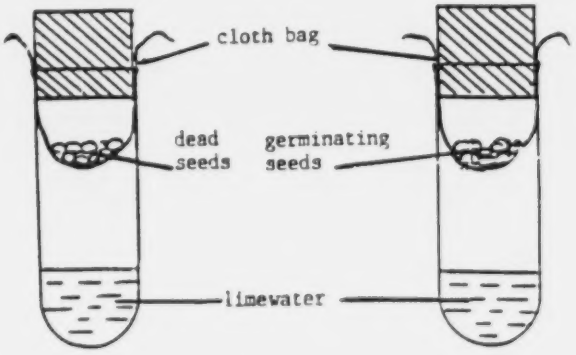


Fig. 03

Leave the apparatus set up for 12 - 24 hours. Then answer the following questions:

1. Why were dead seeds used?

2. Does the limewater turn milky in any of the two test tubes? If so, why?

Skills to be tested

Manipulation

Observation

Interpretation

6. Examining a Bony Fish

Materials:

a small fresh fish

a pair of hand lens

a knife or scalpel

Method:

Obtain a fresh bony fish

1. Identify the operculum or gill cover and the floor of the mouth.
2. Raise the operculum and identify the gills. How many are there?
3. Carefully remove the gill from one side of the head and examine it.
4. Identify the gill bar, gill rakers and gill filaments.

Skill to be tested:

Observation

7. To Illustrate the Ability of Different Types of Surfaces to Absorb Radiation

Materials:

- cardboard
- white paper
- gum
- 2 sheets carbon paper
- aluminium foil
- candle wax
- 1 lamp
- 4 coins

Method:

1. Cut four square pieces of cardboard the same size.
2. Treat each piece in one of the following ways:
   (a) Cut a piece of white paper of the same size and stick it on to one square.
   (b) Cover the second square with carbon paper, the dull side up.
   (c) To the third square, again cover with carbon paper, this time, put the shiny side up.
   (d) Cover the fourth square with aluminium foil or some other silver paper.
3. Get four coins of the same type. To the other side of each square attach one coin by means of a little melted candle wax. Try to use the same amount of wax for each one. [You may try using 2 or 3 drops of melted candle.]
4. Remove the shade from a reading lamp and turn on the light. (The filament of a lighted bulb gives off radiation.)
5. Hold each square, one at a time, the same distance (about 10 cm) from the lamp and note the time it takes for each coin to drop off.

Observation:

	SURFACE	TIME
	dull black	
	shiny black	
	dull white	
	silver	

Explanation:

As the squares get hot, the wax will soften and the coins will fall off. A better absorber takes a shorter time to attain a high enough temperature to melt the wax.

Conclusions:

From the result of the experiment draw your conclusions about the relative ability of surfaces to absorb radiation.

8. Evaporation and Heat

Materials:

water test-tube ether beaker tubing

Method:

1. Put a small amount of water in a test-tube.
2. Place the test-tube with water into a small beaker of ether.
3. Using a piece of tubing, blow into the ether.

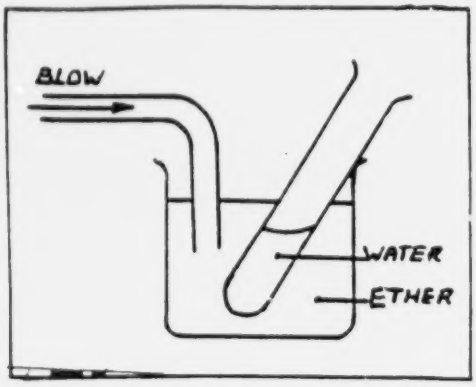


Fig. 04

WARNING!! ETHER IS INFLAMMABLE
Extinguish all flames in the room.

ETHER IS ALSO HIGHLY POISONOUS IF INHALED IN LARGE AMOUNTS

Do this experiment out of doors
or in a room with the windows open

4. Write up your observations about what happens to the water.
5. How do you explain these observations?

NOTE: Did you know that in the Activity above you made a mini-refrigerator?

9. Expansion of Solids

Materials:

a length of thin metal wire, e.g., iron or copper.

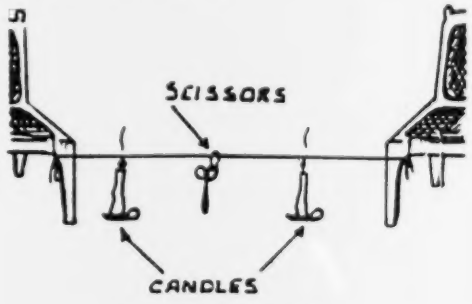
2 chairs

a pair of scissors

candles

Method:

1. Fasten the wire between two chairs.
2. Hang a pair of scissors in the middle of the wire. The scissors should just miss touching the floor.
3. Start the scissors swinging.
4. Heat the wire on each side of the scissors along its entire length with the two candles.



Expansion of Solids

Fig. 05

Questions:

1. Does the pair of scissors keep swinging as the wire is heated?
2. What must have happened to the length of the wire since the chairs were not moved?
3. Watch the wire as it cools. What happens to the pair of scissors?
4. What happened to the wire as it cooled?

10. Expansion of Liquids

Materials:

red ink

test-tube

cork with hole

6" glass tubing

candle or other heat source

Method:

1. Fill a test-tube with water and colour it with red ink.
2. Wet the glass tube and fit it into the hole in the cork.
3. Fit the cork with tubing into the test-tube. The red liquid will rise up the tube.
4. Mark the tube at the top of the liquid.
5. Heat the bottom of the test-tube. **DO NOT LET THE LIQUID BOIL**

Expansion of Liquids

Fig. 06

Questions:

1. What happens to the liquid in the tube as it is heated? Explain why.

2. What happens to the level of the liquid in the tube as it cools? Explain why.

11. Safety rules when using voltmeters

Here are some safety rules you should observe when using voltmeters:

1. If the voltage is not known, use the highest range voltmeter available.

2. If you know the maximum voltage to be measured, use a voltmeter with a range that exceeds the maximum value.

3. Connect the voltmeter in the circuit **before** turning the power supply on.

4. Never touch the circuit or components when the supply is **on**.

5. Use only one hand if you need to make any alterations in the circuit while the power is on.

6. Now that you know the safety rules, you are ready to proceed with the next experiment.

12. Measuring Current

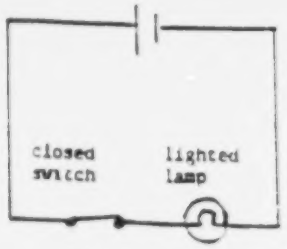


Fig. 07

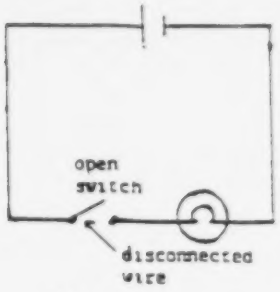


Fig.08

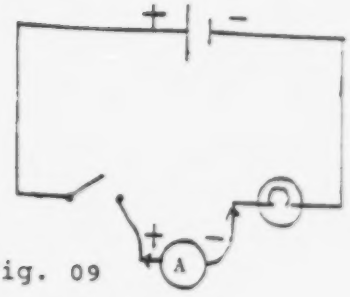


Fig. 09

Consider the circuit of Fig. 07. Set up a circuit like the one shown. You are going to measure the current flowing through the lamp. The following steps describe how this is done.

1. Open (i.e., turn off) the switch. This is a safety measure to ensure that no current flows through the circuit when the ammeter is connected, thus avoiding damage to the ammeter.

2. Disconnect the wire at one end of the lamp. See fig. 08.

3. Connect the ammeter between the lamp and the wire as shown in fig. 09. Make sure that the ammeter is connected to the positive side of the opening in the circuit.

4. Close the switch and note the ammeter reading.

VOLTAGE OR POTENTIAL DIFFERENCE

Voltage or potential difference is described as the force on the charged particles between two points in a circuit. The two points must be specified. For example, we can talk about the voltage across a lamp or between two labelled points A and B in the circuit.

13. Measuring Voltage

A voltmeter is used to measure voltage. The voltmeter usually has a scale marked off in volts or, if very small voltages are to be measured, the scale can be in millivolts or even microvolts. As for current, we do not use the complete words but abbreviate as follows:

Unit	Abbreviation
Volt	V
millivolt	mV
microvolt	μV

Table 03: Abbreviation for Measuring Voltage

When measuring voltage, you must take care that the positive terminal of the voltmeter is connected to the positive terminal of the battery. This time, however, the meter is connected in parallel, i.e., **across** the conductor whose voltage is to be measured and not in the same line as when measuring current. This is illustrated below. Parallel connections are dealt with more fully in Lesson 6 of Module 10.

Method:

Consider again the circuit of Fig. 10. We are going to measure the voltage of the lamp. This time there is no need to disconnect the wire from the lamp. Here is how to do it.

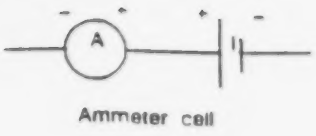


Fig. 10

1. Open the switch. Remember that this precaution must always be observed when you begin to work on a circuit.

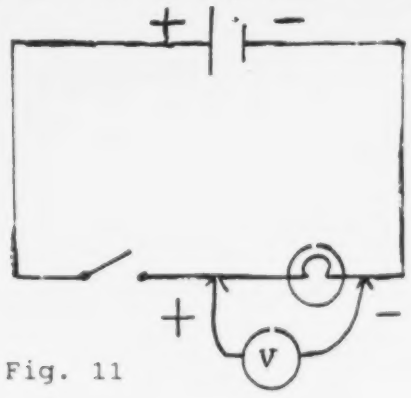


Fig. 11

2. Connect the voltmeter, as in Fig. 11, making sure that the positive terminal of the voltmeter is connected to the positive terminal of the cell.

3. Close the circuit and note the voltmeter reading.

14. Determining Resistance

Generally, the resistance of a conductor is not measured directly with a meter. The voltage across it and the current through it are both measured and the resistance worked out by dividing V by I. The following activity describes how this is done.

We are still dealing with fig. 07. This time you are going to measure the resistance of the lamp. You can do this by following the steps below.

Method:

1. Open the switch. Remember that this precaution must always be observed.

2. Follow the steps outlined below for connecting the ammeter and voltmeter. Your circuit should be as shown in Fig. 12.

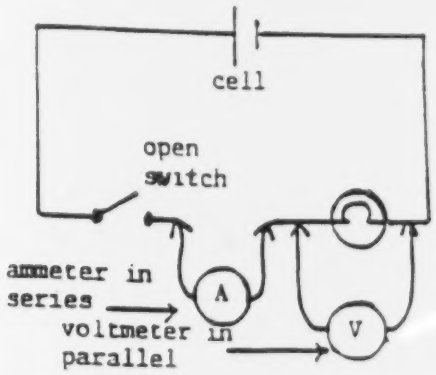


Fig. 12

3. Close the switch. Note the voltmeter and ammeter readings.

4. Determine resistance by dividing volt reading (V) by ammeter reading (I).

15. The Conductivity Tester

Here's another practical activity you will enjoy doing. We are going to make a conducting tester which provides a simple test to determine whether a material conducts electricity or not. The tester is made up from a simple circuit consisting of:

- the material to be tested
- a dry cell
- a flashlight bulb

Conducting the Test

The items are arranged in the circuit as shown below:

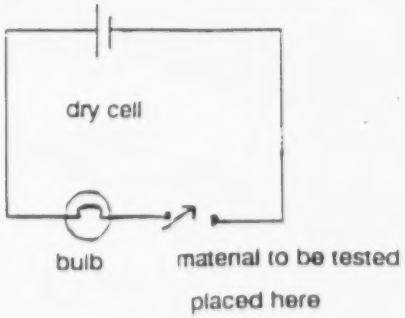


Fig. 13

Results of Test:

The test material is placed in the position shown to complete the circuit. If the bulb lights then the material is a conductor. If the bulb does not light then the material is an insulator.

16. Determining the pH

Materials:

pH paper

fruit juice

vinegar

soap

bleach

Hints:

(a) For powders make a solution in water.

(b) For sprays - spray on a piece of clear glass and add indicator.

Method:

1. Investigate the pH value of juices, vinegar, soap, bleaches, aerosol sprays, any other household substances.

2. List the brand names.

3. Name the active ingredient.

4. Sort them out in a table as weak acid, strong acid, neutral, weak alkali, strong alkali.

17. To Observe the Changes in pH as an Acid is Added Gradually to a Base

Materials:

sodium hydroxide solution

hydrochloric acid (of similar concentration as the hydroxide)

Universal Indicator

2 beakers or glass containers

distilled water

Method:

1. To a beaker half-filled with distilled water, add a few drops of Universal Indicator. Note the colour. Keep this solution as a neutral standard.

2. Add a similar amount of soduim hydroxide solution to a second beaker and add a few drops of Universal Indicator.

3. To the beaker in (2), add a few drops of hydrochloric acid. Continue adding a few drops of acid, noting the colour after each addition.

   Review table 04, and draw conclusions from the results of your experiment.

pH number	1	2 3	4 5 6	7	8 9 10	11 12	13 14
colour	red	pink	beige yellow	green	dark green	light blue	dark blue
strength	strong acid →		weak acid	neu-tral	weak alkali ←		strong alkali

Table 04

18. Preparation of Soap

Materials:

water

sodium hydroxide (caustic soda)

sodium chloride (salt)

castor oil or coconut oil

beaker or heat resistant glass container

heat stirrer (glass rod)

bunsen burner

Method:

1. Place 2 cm^3 of oil in a beaker.
2. Carefully add 2 g of sodium hydroxide which has been dissolved in 10 cm^3 of water. Stir.
3. Heat gently stirring continuously for approximately 3 minutes after coming to a boil.
4. Cool and add 2 g of sodium chloride (salt) which has been dissolved in 10 cm^3 of water. Boil and stir.
5. Pour off liquid leaving white, pulpy mass which is the soap.

WARNING: Sodium hydroxide is highly caustic. HANDLE WITH CARE!!!

19. To Demonstrate the Conditions Needed for Rusting

Materials:

9 nails

9 transparent bottles or test-tubes if you have access to a laboratory

2 well fitting corks or covers

vaseline

sand

shallow metal dish or lid

tripod stand and burner or a stove

methylated spirits

an acid or vinegar

common salt

sodium hydroxide

steel wool or sandpaper

calcium chloride (obtained from laboratory)

magnesium ribbon

copper wire

Method:

1. Clean the nails with the sand paper and wash them with methylated spirit and leave to dry.

2. Put one bottle filled, with water, on sand in a shallow dish. Place the dish on the stove and boil the water for a few minutes. Remove from the stove and stopper with a well fitting cork which has been greased with vaseline.

3. Rinse another bottle with methylated spirit. Use a hair dryer to dry the bottle. Cover the bottle and let it cool.

4. Set up the experiments as shown in the following diagrams.

5. Leave for one week.

6. Note the appearance of the nails each day.

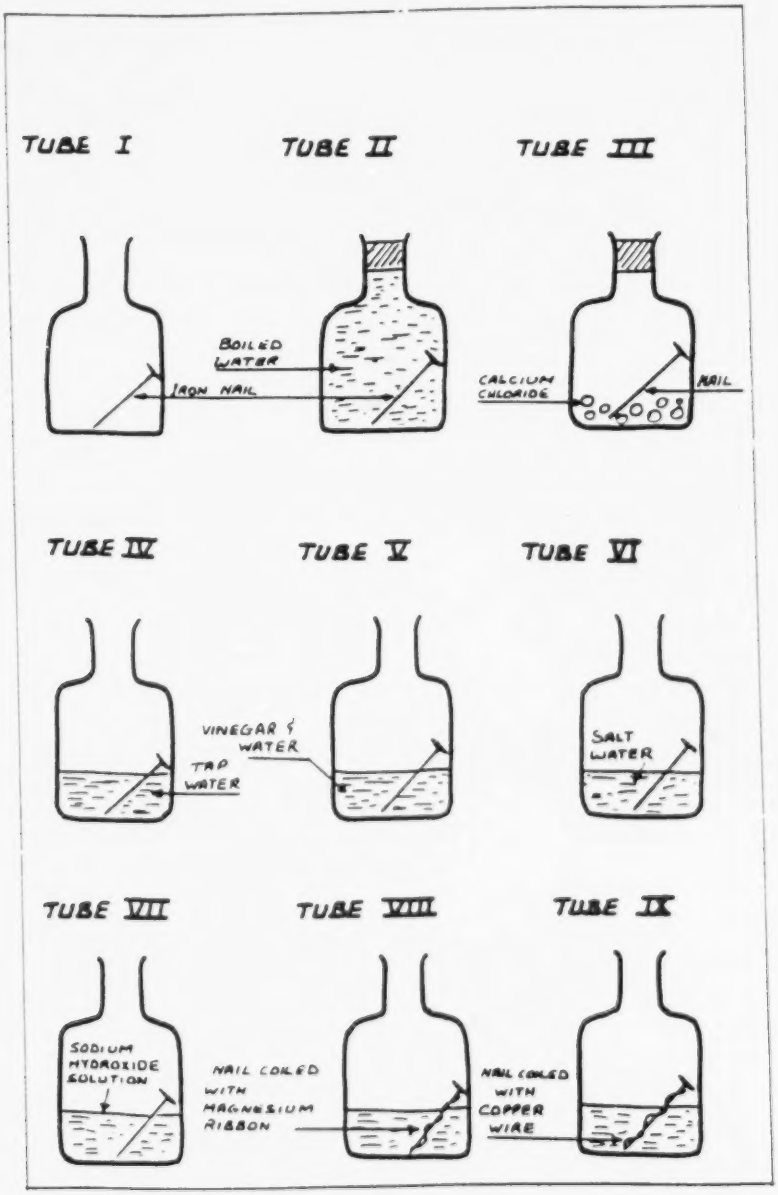


Fig.14

RESULTS

Copy and complete the table below.

DAY->	TUBE I	TUBE II	TUBE III	TUBE IV	TUBE V	TUBE VI	TUBE VII	TUBE VIII	TUBE IX

Table 05: Record of Rusting Conditions in Nine Tubes

20. Investigating the Elastic Behaviour of Copper

Materials:

1 mm of bare copper wire (0.5 - 1.0 mm thick)

clamps or 2 concrete bricks

1 nail (6 inch)

weights (if these are not available, use the stone you weighed and labelled in Lesson 4)

a flat pan that can be used to hold the weights

a metre rule or a 12 inch ruler

pencil (to be used for making spring)

graph paper

WARNING:

1. Use new copper wire that has not been stretched before. Previously stretched wire may have developed weak areas.

2. Use wire that has not been coiled before. Previously coiled wire may have twists remaining in it that may lead to an uneven spring.

Making the Spring:

1. You will need at least 80 cm of wire. This should be sufficient to make 30 turns on your spring.

2. Make a twisted loop at one end of the wire as shown in fig. 15(a). This can be done by winding tightly on the nail.

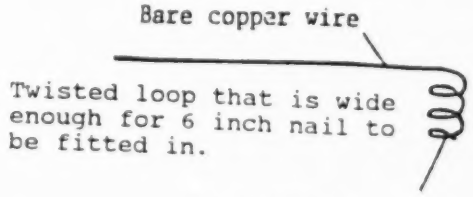


Fig. 15 (a)

3. Wind the rest of the wire tightly about 30 times around the pencil. See figure 15 (b)

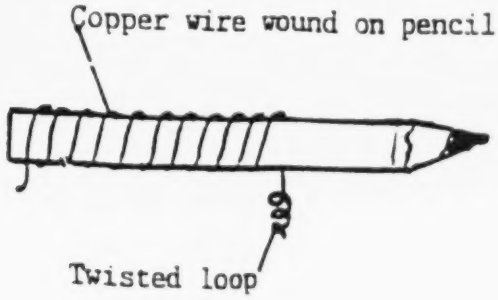


Fig. 15 (b)

4. Make another twisted loop at the other end of the wire after removing from the pencil. Your copper spring is now complete.

Arranging the apparatus

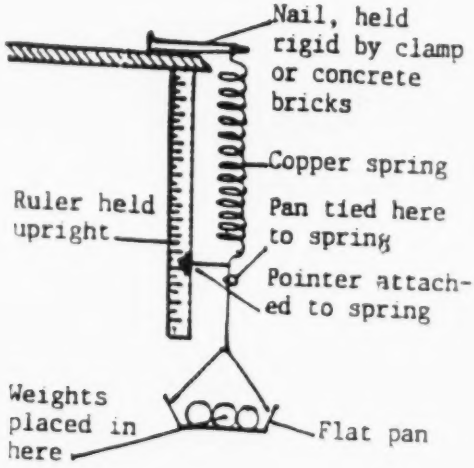

Nail, held rigid by clamp or concrete bricks
Copper spring
Ruler held upright
Pan tied here to spring
Pointer attached to spring
Weights placed in here
Flat pan

Fig. 16

Arrange the apparatus as shown in figure 17 on the previous page by completing the following steps.

1. Hang the spring on the nail.

2. Support the nail with the clamp or concrete blocks in such a way that the spring hangs straight down.

3. Attach a pointer to the free end of the spring. Use a straight pin (common pin) as the pointer. The pin can be attached to the spring by using a small piece of plasticine or sello tape (scotch tape).

4. Securely attach the pan to the free end of the spring as shown in figure.

5. If you can, fix the ruler so that it is permanently behind the spring. If not, support it with one hand while you are taking readings.

Taking Readings

WARNING:

Before you start to take the readings, check that the turns on the coil are separated from each other. If they are not, add masses to the pan until they just separate. Failure to do this may mean an incorrect first reading.

A. You need to take readings of:

1) the force producing the distortion (stretching) of the spring. This is the total weight in the scale pan.

2) the extension produced by each force. Figure 17 shows you how to do this.

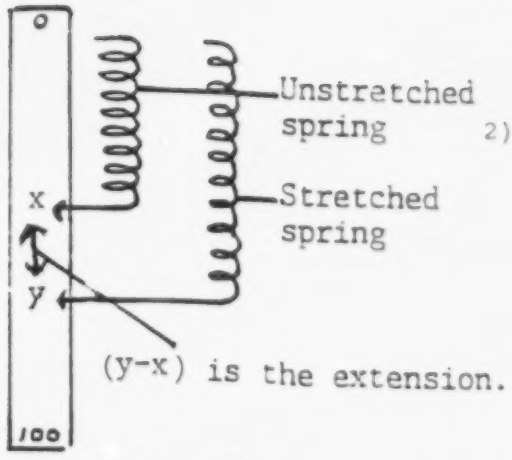


Fig. 17

a) Note the position of the pointer before you start adding the weights (x).

b) Note the position of the pointer after each new weight is added (y).

c) Subtract x from y to get the extension.

B. You will need to take about 10 measurements of force (weight) and extension. For each new reading, increase the weight in the pan by about 10 g.

C. Record your readings in a table like that on the next page.

Original Position of Pointer, x = cm			
Measurement	**Force F/N**	**New Position of pointer, y/cm**	**Extension (y-x)/cm**

Table 06: Ten Recordings of Force and Extension

Using Your Readings:

You will need to plot a graph of force against extension. If you do not know how to plot a graph, refer to your marker/tutor in a telepone tutoring or face to face session.

Put the extension, (y-x) on the x-axis and the force, F on the y-axis. Choose a scale that enables you to use up as much of the graph paper as you can.

Your Results:

The graph you obtain should look like this graph below.

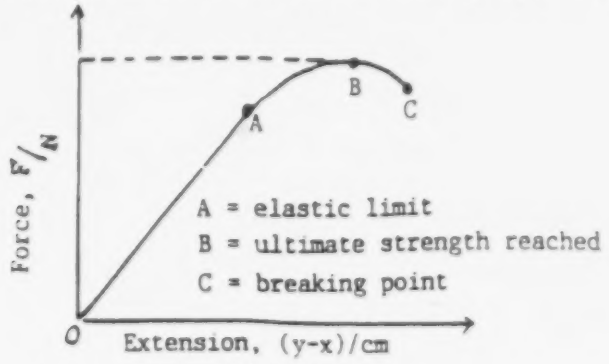


Fig. 18

Note that the graph consists of a straight portion (OA) followed by a curve ABC. See figure 18.

If your graph differs significantly from our graph, you may have made one of the following errors:

(1) **If no obvious line through your set of points:**

Readings are incorrect. You will have to re-do the experiment.

(2) **If only straight portion OA:**

Readings are incomplete. Continue adding weights to the pan. Plot the new points you get until your graph has the correct shape.

Interpreting the Graph:

The straight line between O and A shows that Hooke's law is obeyed in that region. The spring is elastic and will return to its original length if the weights are removed from the pan. At point A the spring has reached its elastic limit. Beyond this point the material is no longer elastic. The extension is no longer proportional to the force.

The portion of the graph between A and C shows what happens when the spring is stretched beyond its elastic limit. Here the force is no longer proportional to the extension. The same force produces a bigger and bigger extension. If you were to remove the weights from the scale pan now, the spring would not return to its original length but would have a permanent extension. The spring is said to have a **permanent set.**

Point B on the diagram marks the ultimate strength of the material. This is the greatest force that can be applied before it breaks.

21. Let There Be Light

To Find the Focal Length of Convex Lenses.

Apparatus/Materials:

a light bulb

3 convex lenses of different focal lengths

plasticine

metre rule

a wooden box with two adjacent sides open to encase the bulb

2 pieces of white cardboard 15 cm x 15 cm. 1 piece of cardboard should have a hole in the centre.

4 pieces of wood to use as a stand for the cardboard

tape

Instructions:

1. Attach the plasticine to the edge of the lens on one side.
2. Place one edge of each piece of cardboard between two pieces of wood. Use tape to keep them together so that the pieces of wood serve as a stand.
3 Arrange the apparatus as shown in fig. 19.

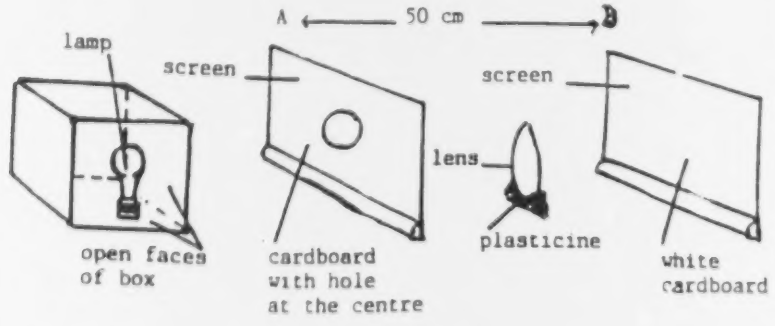


Fig. 19

4. Move the lens labelled 1 between A and B until a sharp image appears on the screen. You may also need to move the screen a bit.

5. Measure the distance between the lens and the screen. This distance is the focal length of the lens.

6. Record your answer in table 07.

7. Repeat the experiment for Lens 2 and Lens 3

LENS	FOCAL LENGTH
1	
2	
3	

Table 07: Three Recordings of the Focal Length of Convex Lenses

Instructions for Setting Up Practicals:

1. The lens should have a focal length of range 10 cm to 30 cm.

2. The lenses should be labelled 1, 2 and 3.

22. Vision and Lighting:

To Investigate the Efficiency of a Filament Bulb

Materials/Apparatus:

a thermometer 0°C - 100°C

a 12V 36 W lamp

lamp holder

clamp

a 12 V D.C. power pack

a can or beaker

water

a small immersion heater rated 40 W (or as close to the power of the lamps as possible)

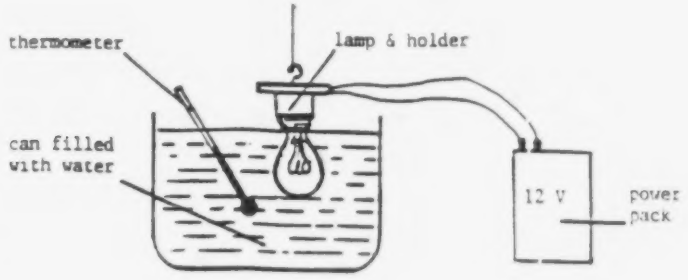


Fig. 20

Instructions:

1. Clamp a 12 V 36 W lamp and holder upside down above a can filled with water from the tap. Measure and record the temperature.

2. Lower the lamp so that the glass bulb is completely under water and switch on for 5 minutes.

3. Measure the highest temperature recorded and calculate the temperature rise produced by the lamp. Record your answer in the following table.

	Initial Water Temp. (°C)	Final Water Temp. (°C)	Temperature Rise (°C)
filament lamp			
immersion heater			

Table 08: The Water Heater

4. Repeat the experiment using fresh water from the tap and the immersion heater. Again record the highest temperature reached after heating for 5 minutes.

How does the lamp compare with the immersion heater as a means of heating water?

23. Separating Ink by Chromatography

Materials:

solvent, water (remember the substitutes suggested above for these solvents.)

small test-tube

filter paper

ink

Arrangement of Apparatus:

1. Pour water in a small test-tube up to about 2 cm high. Put in stopper.

2. Cut a strip of filter paper about the same length as the tube.

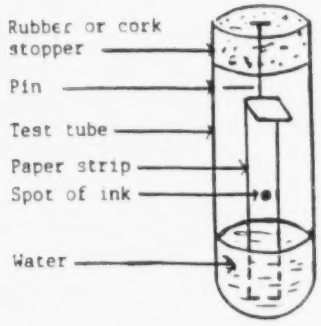


Fig. 21

3. Place an ink spot about 3 cm from one end of paper strip and allow it to dry.

4. When the ink spot is dry add more drops to the same spot letting each spot dry separately. This will build up a really concentrated spot of ink.

5. Hang the paper strip in the test-tube with one end just dipping into the solvent (water).

6. Leave for five minutes.

   What happens? Why?

24. To Show that Light is Necessary for Photosynthesis

Before you begin this Activity.

Please review module 17 again before you begin to see how:

to decolourize a leaf (Activity 01)
to check a leaf for starch (Activity 02)
to destarch a leaf (Activity 04)

Materials:

a destarched leaf.

paper clips

a strip of aluminium foil

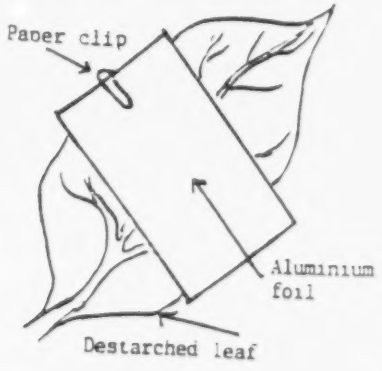


Fig. 22

Method:

1. Place the aluminium strip over the leaf and hold it in place with the paper clip.

2. Leave the plant in the light for 2 or 3 hours.

3. Remove the foil. Decolour the leaf and test both covered and uncovered parts for starch.

How do the covered and uncovered part of the leaf compare? What conclusions can you come to?

25. To Study the Effect of Different Surfaces on the Bounce of Different Types of Balls

Materials:

metre rule masking tape

cricket ball rubber ball

dirt or sand water

piece of board of dimension 30 cm x 90 cm

concrete surface

N.B. This experiment should be done on a concrete surface close to a wall or wooden frame.

Method:

1. Put the metre rule to stand straight against the wall or wooden frame. Use masking tape to keep it in place.

2. Release the cricket ball from a predetermined height and observe the height to which it bounces. Repeat 2 more times, releasing the ball from the same height each time. Record your results in the table which follow.

3. Find the average of the three readings and record it in the column labelled 'AV'

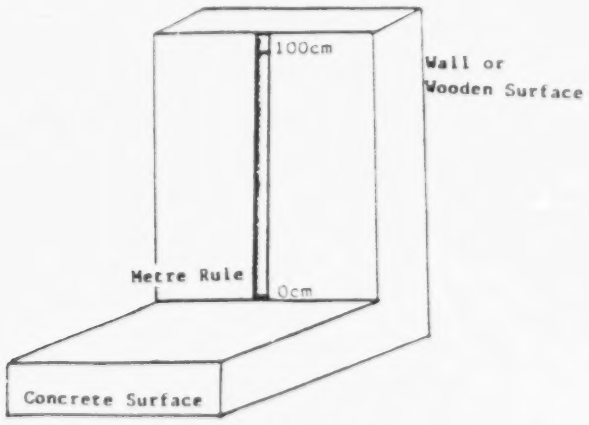


Fig. 23

4. Now place the piece of board on the concrete surface and repeat Steps 2 and 3.

5. Remove the piece of board and pour enough dirt or sand in its place so that the concrete surface is completely covered. Repeat Steps 2 and 3.

6. Wet the dirt and repeat Steps 2 and 3.

7. Do Steps 2 - 5 again, this time using the rubber ball instead of the cricket ball.

A. Cricket Ball

Type of surface	**Height of bounce**			
	1st	2nd	3rd	AV
Concrete				
Wood				
Dry dirt/sand				
Wet dirt/sand				

Table 09: Comparing Type of Surface and Height of Bounce of a Cricket Ball

B. Rubber Ball

Type of Surface	**Height of Bounce**			
	1st	2nd	3rd	AV
Concrete				
Wood				
Dry dirt/sand				
Wet dirt/sand				

Table 10: Comparing Type of Surface and Height of Bounce of a Rubber Ball

Answer the following from your results:

i) Which surface gave the highest bounce? _____

ii) Which ball gave the highest bounce? _____

To Compare the Stretching Ability of Different Types of Wood

Materials:

2 retort stands — metre rule

a 2 lb - 3 lb can — a length of wire

equal lengths of an old bat

white pine and pitch pine; they should be of equal thickness.

1. Set up the apparatus as in fig. 24 below, using the length of wood from the old bat.

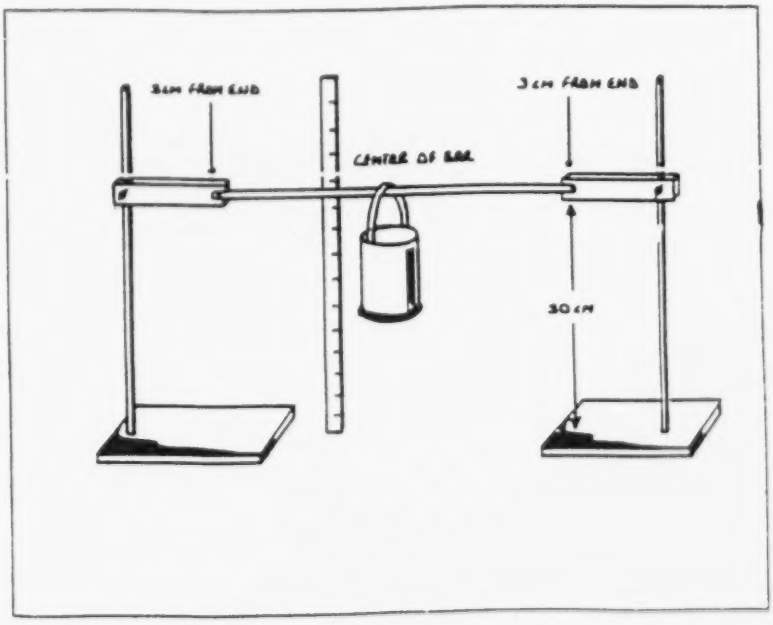


Fig. 24

2. Note the reading on the rule, i.e., the height of the centre of the length of wood when the can is empty, and record your reading in the table below.

3. Add water gradually to the can until the length of wood begins to sag. Record the new reading on the rule.

4. Find the difference between the two readings from the rule and write your answer in the column 'Distance Sagged'.

5. Repeat Steps 3 and 4 by replacing the length of wood from the old bat with the length of white pine and then with the pitch pine.

Type of Wood	Read 1	Read 2	Distance Sagged
old bat			
white pine			
pitch pine			

Table 11: Comparing the Elasticity of Wood

Which type of wood has the most elasticity?

27. Investigating the Effect of Angle of Projection on Range

Materials:

catapult
protractor
measuring tape

Method:

Arrange the apparatus as shown in fig. 25 below. The protractor is supported vertically. The catapult is placed next to it.

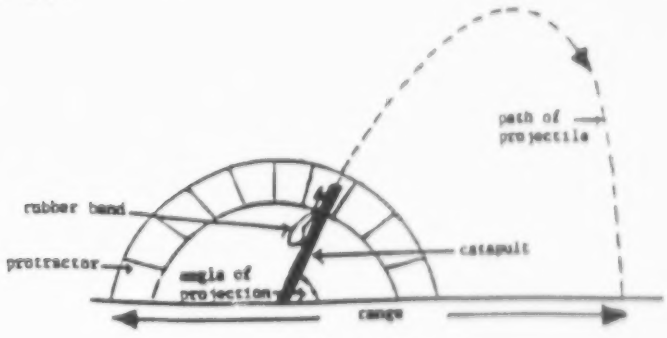


Fig. 25

The projectile is placed within the rubber band and the rubber band drawn back until it just reaches the line marked on the board. The projectile is released. The angle of projection is noted and the range measured with the tape. Draw up a table like this one.

ANGLE /°	RANGE / m	AVERAGE RANGE

Table 12

Note also that the same horizontal range can be obtained from two different projection angles. The pair of angles must add up to 90°

28. Investigating Parts of a Flower

Materials:

2 flamboyant flowers 1 hand lens 1 scalpel/knife

Method:

Collect two flamboyant flowers [delorux regia]. (Hibiscus can also be used). With the aid of a hand lens, examine one of the flowers:

1. Locate the **stalk** of the flower. The uppermost end of the stalk is swollen. This is the **receptacle**.

2. Attached to the swollen end are a set of **rings** (whorls). Starting from the outside and moving in, the first structures you will see are the **sepals**. Locate them on your flower. There should be five. Remove one of these structures and draw it.

3. The next ring (whorl) are the **petals**. They are brightly coloured in the Flamboyant. Again this flower has five petals. Remove one and draw it.

4. Inside of the petals are the male and female reproduction parts. The male part is called the **stamen** and the female part the **pistil**. In the flamboyant, the male part is distinguishable because there are 10, five short and five long. Each stamen consists of an anther and a filament. Remove one and draw it. At the centre of the flower surrounded by the stamen is the pistil.

   The pistil has three parts. The enlarged part at the bottom is the **ovary**; the stalk is the **style** and the bump is the **stigma**. Try to find all of these structures.

5. With a sharp scalpel or knife, cut the pistil length-wise. What do you see in the ovary? Small round structures. These are the ovules. Draw the cut surface of the **carpel**.

Skills to be tested:

Manipulation
Recording

29. Does Temperature Matter to Germination?

Materials:

24 pigeon peas
6 small containers (jam jars are adequate)
toilet paper or newspaper (enough to line the 6 containers)

Method:

A

1. Place about 1 cm depth of water in two jam jars, then line the jars with toilet paper or newspaper.

2. Take 8 of the 24 seeds, soak them, then place 4 seeds between the paper and the jar in each of two jars, about 5 cm from the bottom as shown in fig. 26.

3. Place one jar in the refrigerator and leave the other at room temperature.

4. Check the appearance of the seeds every day. Replace water if needed.

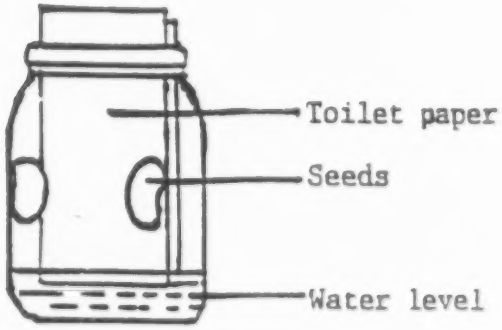


Fig. 26

Record your observations and make a conclusion about this activity.

B Repeat the experiment, setting up as in A but substitute the following:

water in one jar, no water in the other

C coat the seeds from one jar with vaseline to exclude oxygen and leave the others as they are.

Record your observations and make conclusions.

Skills to be Tested:

Manipulation
Observation
Interpretation

30. Making a Graph

Materials:

sheet of graph paper

pencil

ruler

a sample of 30 students

Method:

Use a sample of students from classes I to V. Record the height of the boys separately from those of the girls. Use those students who are not of the same age and try to get an age range. (It is all right to use about 10 students per group).

Plot a line graph showing your results. Use a continuous line for the boys and a broken line for the girls.

Answer the following questions:

1. Are there any differences in height between boys and girls?

2. If the answer is "Yes", at what particular age range do these differences occur?

3. Can you explain the reason for this, using previous knowledge?

Skills to be Tested:

Recording

Interpretation

31. Solar Cooker

Materials:

1 magnifying glass

1 plate or saucer

bits of paper

Method:

1. Place the paper on the plate.
2. Focus the sun's rays on the paper, using the magnifying glass.
3. Observe what happens.

Observations:

The paper begins to char and will burn if the sun is hot enough or if you focus the rays long enough.

To get enough heat in solar cookers, concave (curved) reflectors are used. The reflector consists of a shiny surface. It reflects the solar energy on to the pot which is placed at the principal focus of the reflector. (See Module 15, Lesson 2). Heat energy concentrates at this point and the pot is brought to the boil.

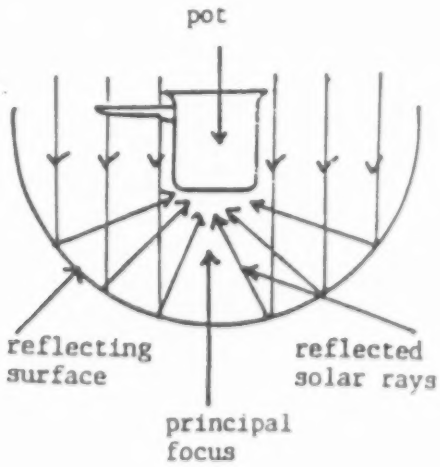


Fig. 27

32. Balloon Rockets

Materials:

balloons
masking tape
drinking straws
scissors
fishing line or twine

Method:

1. Blow up a balloon. Pinch the mouth shut. Turn it in any direction and release it.

   What happens?

Fig. 28

2. Repeat Step 1 several times releasing the balloon in a different direction each time.

   What do you notice?

   Can you control the balloon's direction?

Try this.

3. Blow up the balloon. Pinch the mouth shut.

4. Attach straws to the balloon with tape and run fishing line through the straws as shown in fig. 29

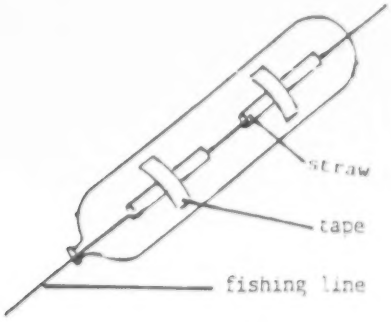


Fig. 29

5. String the fishing line across the room as shown in fig. 30.

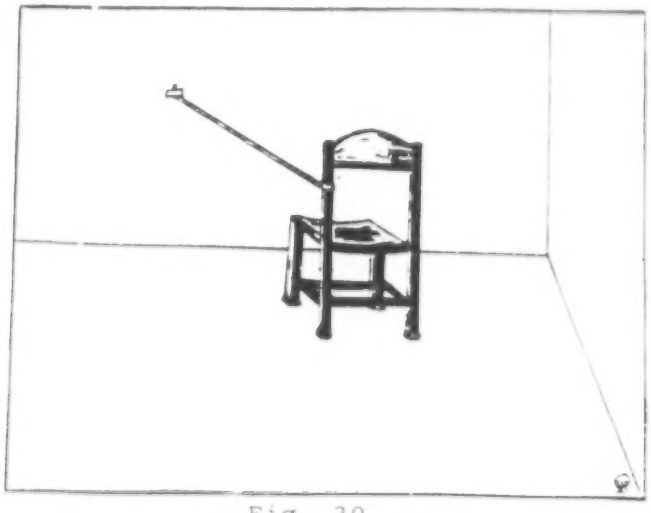


Fig. 30

6. Now draw the balloon to the end of the line and release it.

What happens?

Can you control the balloon's speed?

How do you think this can be done?

7. Try putting varying amounts of air into the balloon.

   How does this affect its speed?

   Can your balloon carry a load?

8. Tape a flat object (like a piece of cardboard) on to the back of the balloon. How does this affect the balloon's speed?

Explanation:

The balloon acts like a rocket. The air expelled at the mouth is an action force. This creates the reaction force which pushes the balloon in the opposite direction.